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# Chart Review: Identification of Torticollis and Plagiocephaly in an Infant Toddler Screening Program

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Chart Review: Identification of Torticollis and Plagiocephaly in an Infant / Toddler  
Screening Program

by

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A Scholarly Project

Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine

University of North Dakota

in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy

Grand Forks, North Dakota

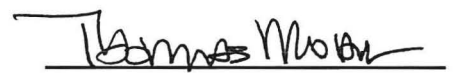
May 2007



This Scholarly Project, submitted by Kari Ell and Cara Mobley in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.



(Graduate School Advisor)



(Chairperson, Physical Therapy)

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Title                      Chart Review: Identification of Torticollis and Plagiocephaly in an  
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Department              Physical Therapy

Degree                    Doctor of Physical Therapy

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Cara Mobley

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## ABSTRACT

As the incidence of torticollis and plagiocephaly have increased since the initiation of the Back to Sleep campaign in 1992, greater awareness of diagnosis and prevention for these conditions is imperative. The purpose of this study was to complete a chart review which identified the birth history risk factors and diagnostic indicators for torticollis and plagiocephaly that were documented, the variations in identification and referrals by discipline of screener, and the incidence of torticollis and plagiocephaly in infants and toddlers receiving services through a rural screening program of a midwestern state. A retrospective chart review of 125 children (birth to 3 years of age) screened by various professional disciplines through a developmental screening program between July 2004 and July 2006 was completed. Of the 125 charts reviewed, 90 met the established inclusion criteria. The mean age at the initial screening was  $1.92 \pm 1.45$  months, and the mean birth weight was  $7.43 \pm 1.51$  pounds. Plagiocephaly was found in 8 (8.9%) and torticollis in 3 (3.3%) of infants. No significant relationships were found between risk factors (gender, vacuum assisted delivery, or prematurity) and the presence of a diagnostic indicator of torticollis or plagiocephaly. Recommendations including expansion of early screening and use of a standardized in-take form for birth details could potentially benefit future recipients of the program's services. Limitations for this study were a small sample size, lack of randomization, and missing information in the charts.

## CHAPTER I

### INTRODUCTION

Pediatric healthcare professionals are often presented with parenting concerns such as feeding, bathing, and appropriate positions for sleeping. However, one facet of infant care that is often overlooked is that of regular, supervised prone positioning (tummy time), which is necessary for the promotion of normal infant development.<sup>1</sup> This has become a concern recently attributable to the change in recommended sleeping positions in attempt to reduce the occurrence of sudden infant death syndrome (SIDS), which is the leading cause of death among neonatal infants in the United States.<sup>1-4</sup>

In 1992, the American Academy of Pediatrics established the recommendation of positioning healthy, full-term infants in supine or on their backs for sleeping.<sup>2</sup> A 1996 revision statement removed the exception of premature infants, mandating that all infants be placed in supine, pending contrary physician recommendations.<sup>5</sup> Since the proclamation of the “Back to Sleep” campaign, the number of infants sleeping in the prone position dropped from 70% in 1992 to 24% in 1996, which corresponds to the steady decline in the incidence of SIDS.<sup>3,5</sup> Aside from the success in the reduced number of infant deaths from SIDS, the incidence of congenital muscular torticollis (abnormal posturing of the head and neck)<sup>6</sup> and positional plagiocephaly (cranial flattening)<sup>7</sup> has been speculated to have increased, in conjunction with the associated delay in acquiring gross motor milestones.<sup>1,8</sup>



### Problem Statement

In accordance with worldwide trends,<sup>8-10</sup> an apparent increased incidence of torticollis and plagiocephaly in infants and toddlers has been observed within an infant developmental screening program of a midwestern state.

### Purpose of the Study

The purpose of this study is to complete a chart review to identify documented birth history risk factors and diagnostic indicators for torticollis and plagiocephaly, the variations in identification and referrals by discipline of screener, and the incidence of torticollis and plagiocephaly in children birth to 3 years of age receiving services through a rural infant/toddler screening program.

### Significance

The results of this study have the potential to benefit future recipients of the program's services through enhancement of the current screening and referral process of torticollis and plagiocephaly within the infant developmental screening program.

### Research Questions

Through a chart review, the following research questions will be addressed:

1. Which risk factors are associated with the diagnostic indicators of torticollis and plagiocephaly?
2. Does identification and referral for further evaluation of torticollis and plagiocephaly vary among professional discipline of screeners?
3. What is the estimated incidence of torticollis and plagiocephaly within this population between July 2004 and July 2006?

## Hypotheses

It is hypothesized that the diagnostic indicators used by screeners within the infant developmental screening program to identify torticollis and plagiocephaly will be congruent with those reported in current literature. A supporting hypothesis is that the professional discipline of the screener will not influence the identification and referral for further evaluation of torticollis and plagiocephaly. In addition, the incidence of torticollis and plagiocephaly is speculated to mirror the incidences reported in literature.

## CHAPTER II

### REVIEW OF LITERATURE

#### Introduction

Infancy encompasses a multitude of changes, for the infant developmentally, as well as placing new demands on the family. Congenital conditions such as torticollis and plagiocephaly may exist from birth or may develop sometime during the first few months of life.<sup>8,11</sup> Due to the profound effects on the infant's joints and muscles, many parents seek medical guidance for management of these conditions to ensure healthy development and acquisition of motor milestones at the appropriate stages.<sup>11,12</sup>

#### Developmental Milestones

To fully understand the effects of torticollis and plagiocephaly, it is essential to recognize the motor milestones of each stage of normal infant development. At birth, the neonate displays physiological flexion with high tone in the extremities and spinal column. As an infant grows and develops over the first few months postnatally, the acquisition of symmetry and muscular control emerges.<sup>12</sup>

#### The First Month

During the first month, the infant becomes increasingly attentive to the surrounding environment. As visual acuity increases, tracking of an object to midline is possible, yet shakily executed. Emergence of the optical righting reaction allows for the righting of the head and neck horizontally through visual stimuli.<sup>12</sup>

When positioned in supine, the infant's head is rarely in midline, which corresponds with preferential head positioning.<sup>12-14</sup> In prone, hyperextension of the neck allows an infant to momentarily lift the head, merely enough to rotate the head to the side to allow for breathing. Because neck flexor strength is deficient, the infant displays a complete head lag with a pull to sit maneuver.<sup>12</sup>

### The Second Month

Throughout the second month of life, muscle tone continues to decrease in the extremities, permitting ease of movement. Visual awareness is enhanced, with the ability to start tracking past midline and potentially up to 180 degrees with adequate stimulation. As the eyes move quicker than the head, visual input facilitates the proper spatial orientation of the head and neck.<sup>12</sup>

Although the neck musculature gradually gains strength, the infant seldom lies in supine with the head in midline. Rotation of the head is possible in prone, as well as briefly lifting the head to 45 degrees. However, a head lag continues to be present with pull to sit. Primitive reflexes such as the asymmetric tonic neck reflex (ATNR) may be elicited with increasing degrees of cervical rotation.<sup>12</sup>

### The Third Month

Symmetry and orientation to midline begin in the third month. By this time, the infant is regularly tracking 180 degrees and initiates vertical tracking. Consideration of a visually pleasing object in midline allows for visual convergence.<sup>12</sup>

For the first time in supine, maintenance of the head in midline can occur, although typically quite momentarily. Increased control of bilateral cervical and capital

neck flexors allows the infant to flex the neck with a chin tuck. In prone, the infant can steadily lift the head to 90 degrees. Thoracic and lumbar extension provides truncal stability for head control, especially when propped up on the forearms.<sup>12</sup>

### Congenital Muscular Torticollis

Congenital muscular torticollis, or simply torticollis, is currently the third leading congenital musculoskeletal anomaly in children, with dislocation of the hip and talipes equinovarus (clubfoot) first and second, respectively.<sup>15</sup> Torticollis originates from the Latin roots, meaning “twisted neck.”<sup>16</sup> Essentially, this condition primarily involves the unilateral shortening of the sternocleidomastoid (SCM) muscle, resulting in an abnormal posturing of the head and neck, potentially leading to delays in developmental milestones and craniofacial asymmetries.<sup>6</sup> Generally, an infant with torticollis displays a head tilt, with the ear pulled down toward the clavicle on the same side, and the face turned upward and away from the affected SCM muscle<sup>17-19</sup> (Figure 1).

Left-sided torticollis is more frequently diagnosed, with approximately 46.6% to 68% of cases involving the left SCM, as compared to right-sided torticollis accounting for 27% to 53.3%.<sup>13,17,19,20-24</sup> There is a male preponderance, with a 3:2 male to female ratio.<sup>7,13,22,25-26</sup>



Figure 1. Clinical Presentation of Torticollis. Sketch by Virginia Achen.

### Etiology

There is minimal agreement as to the specific etiology of congenital muscular torticollis. Nearly 80 different entities have been reported as causative factors of torticollis, including ischemia within the SCM muscle, birth trauma, and intrauterine positioning of the fetus.<sup>6,15</sup> Although the specific etiology of torticollis remains unclear, a variety of clinical subgroup presentations exist under this umbrella term including sternomastoid tumor,<sup>6,7,17,18,20,26-28</sup> muscular torticollis,<sup>6,20,26-28</sup> and postural (positional) torticollis.<sup>6,7,17,20,26-28</sup> Recent research indicated that sternomastoid tumors are the leading contributor to torticollis, comprising 55% to 85% of all reported cases.<sup>17,20,26,29</sup> Muscular torticollis accounts for an additional 34%,<sup>20</sup> and postural for 11% to 15% of the remaining cases.<sup>17,20</sup>

### Subgroup Classification

Torticollis resulting from a sternomastoid tumor, or fibromatosis colli, was reported in German literature as early as 1812.<sup>22</sup> This palpable tumor, composed of collagen and fibroblasts that are irregularly laid down following ischemic trauma, may be located anywhere along the length of the SCM muscle.<sup>6,7,28-28</sup> Via ultrasonography, Dudkiewicz and associates<sup>18</sup> identified these SCM tumors ranging in size from 8 to 15.8 mm in transverse diameter and 13.7 to 45.8 mm in length in a total of 26 infants with a mean age of 4 weeks.

These tumors typically appear within the first 3 weeks postnatally and continue to grow until the infant is approximately 1 month of age. Without treatment, the tumor gradually diminishes during the following 2 to 6 months.<sup>15</sup> The consequential outcome

of the fibrotic tumor is a shortened SCM muscle and resultant head tilt ipsilaterally,<sup>6,17</sup> in addition to a cervical rotational deficit greater than 15 degrees in 72.3% of infants.<sup>20</sup>

Muscular torticollis involves an overall tightness of the SCM muscle.<sup>26</sup> Although stiffness and shortening of the muscle are present, there is no evidence of a palpable mass or SCM tumor.<sup>27,28</sup> However, cervical range of motion is still significantly limited, especially with rotation and lateral flexion.<sup>6,20</sup> Cheng and associates<sup>20</sup> identified a cervical rotational deficit greater than 15 degrees in 31.9% of infants.

Unlike the other presentations of torticollis as discussed above, postural torticollis is not attributable to a tight SCM muscle or a palpable mass.<sup>6,17,26,27</sup> Rather, infants with postural torticollis tend to present with the classic head tilt and persistent side preference during head movements and positioning, with an inability to maintain the head in a midline orientation.<sup>7,20,28</sup> Deficits in range of motion are less of a concern with postural torticollis as compared with the other presentations, as only 4.3% demonstrate deficits of cervical rotation greater than 15 degrees.<sup>20</sup>

### Regional Anatomy

In order to reinforce the biomechanical alterations resulting from the anatomical changes associated with torticollis, an overview of the regional anatomy ensues. The broad, band-like SCM consists of 2 inferior heads that originate from the anterior surface of the manubrium of the sternum and the superior surface of the medial third of the clavicle. The muscle belly traverses the lateral neck and inserts on the mastoid process of the temporal bone, as well as the lateral half of the superior nuchal line of the occiput<sup>30</sup> (Figure 2).



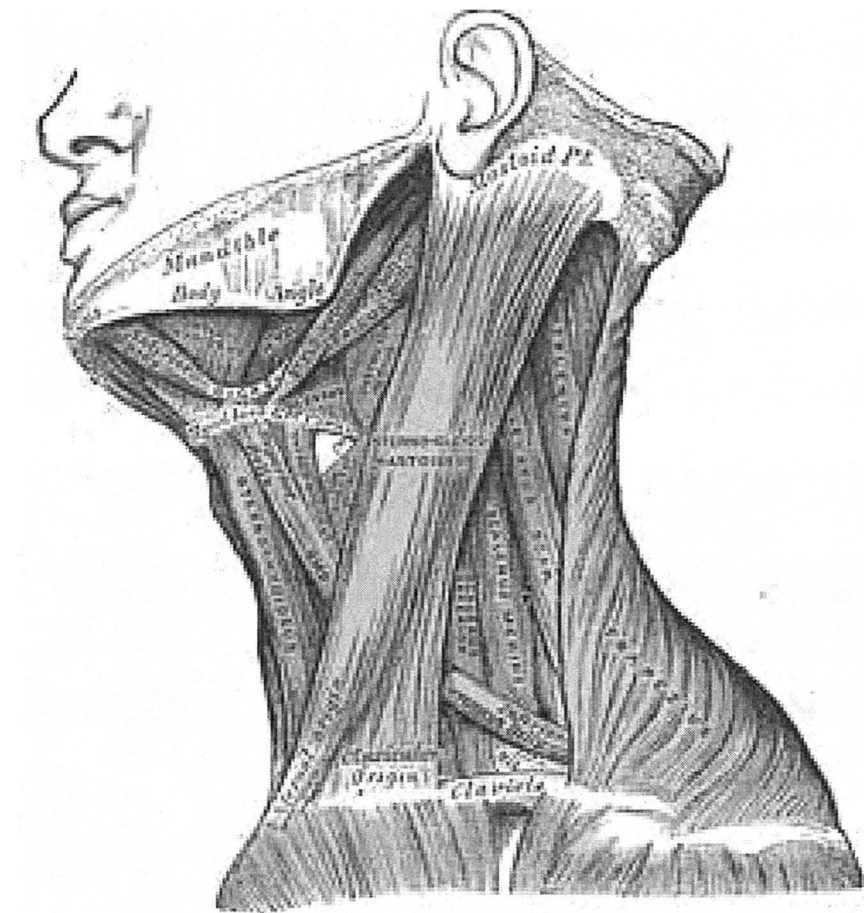


Figure 2. Lateral View of Neck Musculature.

(Public domain: available at: <http://en.wikipedia.org/wiki/Image:Gray385.png>)

A unilateral contraction of the SCM draws the neck into lateral flexion on the same side and contralaterally rotates the head and cervical spine.<sup>17,18,30</sup> When both SCM muscles work simultaneously, the neck flexes anteriorly. Motor innervation to the SCM arises from the spinal root of the spinal accessory nerve (cranial nerve XI), while the sensory portion arises from the second and third cervical nerves (C2 and C3).<sup>30</sup>

In addition to the SCM muscle, other anterior neck musculature such as platysma, scalenes, hyoids, tongue, and facial muscles may contribute to complications associated with torticollis, such as delay with acquisition of oral motor skills and the inability to demonstrate head and neck control when positioned in prone.<sup>6</sup> The upper trapezius may also be involved, further impeding the ability to fully extend the head in prone.<sup>6,31</sup> Other noteworthy anatomical features of this area include the carotid artery, internal jugular vein, great auricular nerve, and facial nerve.<sup>30</sup>

### Incidence

Research prior to the “Back to Sleep” campaign in 1992, indicated an incidence of infantile torticollis ranging from 0.3% to 2.0%.<sup>6,18,20,25,28,29,32</sup> However, a critical review of the literature from the past decade revealed an apparently increased, yet inconclusive incidence of torticollis.<sup>9,10</sup> The ambiguous incidence of this condition can, in part, be attributed to the recent change in recommended sleeping position for infants. Furthermore, an augmented awareness of torticollis among healthcare professionals has allowed for a greater frequency of recognition.<sup>10</sup>

Since the American Academy of Pediatrics’ recommendation, the overall incidence of torticollis has been theorized to escalate endemically in proportion to the

increasing number of infants sleeping in the supine position.<sup>1</sup> A study conducted by de Chalain and Park<sup>23</sup> confirmed the hypothesis of an increasing incidence of torticollis, with only 10 documented cases of torticollis in 1995, and 112 in 2000. The results from this study yielded an incidence of 8.58 cases of torticollis per 1,000 live births, in accordance with a significant increase of craniofacial asymmetries known as plagiocephaly.<sup>23</sup>

### Positional (Deformational) Plagiocephaly

Positional or deformational plagiocephaly is largely reported in literature as a unilateral deformation or flattening of an infant's head.<sup>7</sup> The word plagiocephaly is derived from Greek word roots meaning "oblique or slanting" and "head," emphasizing the unusual shape of the skull.<sup>14,16</sup> Though the specific clinical presentation of this condition is inconsistently described and categorized in literature, asymmetries associated with the unilateral flattening may vary from subtle to severe craniofacial deformities.<sup>7,9,14,23,33-37</sup>

### Etiology

Literature supports opposing theories regarding the etiology of plagiocephaly; uncertainty exists as to whether this condition primarily begins prenatally or postnatally.<sup>14,23,33,38-40</sup> Anatomically, an infant's cranium is composed of 6 free-floating cranial bones (frontal, occipital, 2 temporal, and 2 parietal) connected by fibrous sutures. The spaces between the bones are necessary for both pre- and postnatal brain growth and development. During delivery, the flexibility of these sutures allows for overlapping of

the bones in order for the head to pass through the birth canal without compressing and, therefore, damaging the infant's brain.<sup>41</sup>

In utero, the fetus is most commonly positioned in the left occipital anterior position during the third trimester<sup>14,38</sup> (Figure 3). Bruneteau and Mulliken<sup>38</sup> anticipated that, in this position, the mother's pubic bone and lumbosacral spine compress the infant's compliant cranium in the anterior and posterior aspects respectively, leading to a parallelogram-shaped head. At birth, the infant may display residual cranial abnormalities from either positioning in utero or the birthing process, which may spontaneously resolve or, more frequently, may predispose and progress to further deformational flattening due to the newborn's lack of head and neck control.<sup>6,8,14</sup> Miller and Clarren<sup>37</sup> identified an abnormal head shape at birth significantly increases the risk of developing plagiocephaly postnatally.

Because physiological fusion of the metopic and lambdoidal sutures does not occur for approximately 9 months and 12 to 18 months, respectively, the infant's head is malleable and vulnerable to deformational changes after birth as well.<sup>40,42</sup> Even though the infant's head was seemingly normal shaped at birth, occipital flattening may become apparent around 2 to 3 months of age.<sup>14</sup> This unilateral deformation is speculated by Clarren<sup>40</sup> to develop gradually as the infant assumes a position of comfort while sleeping supine.

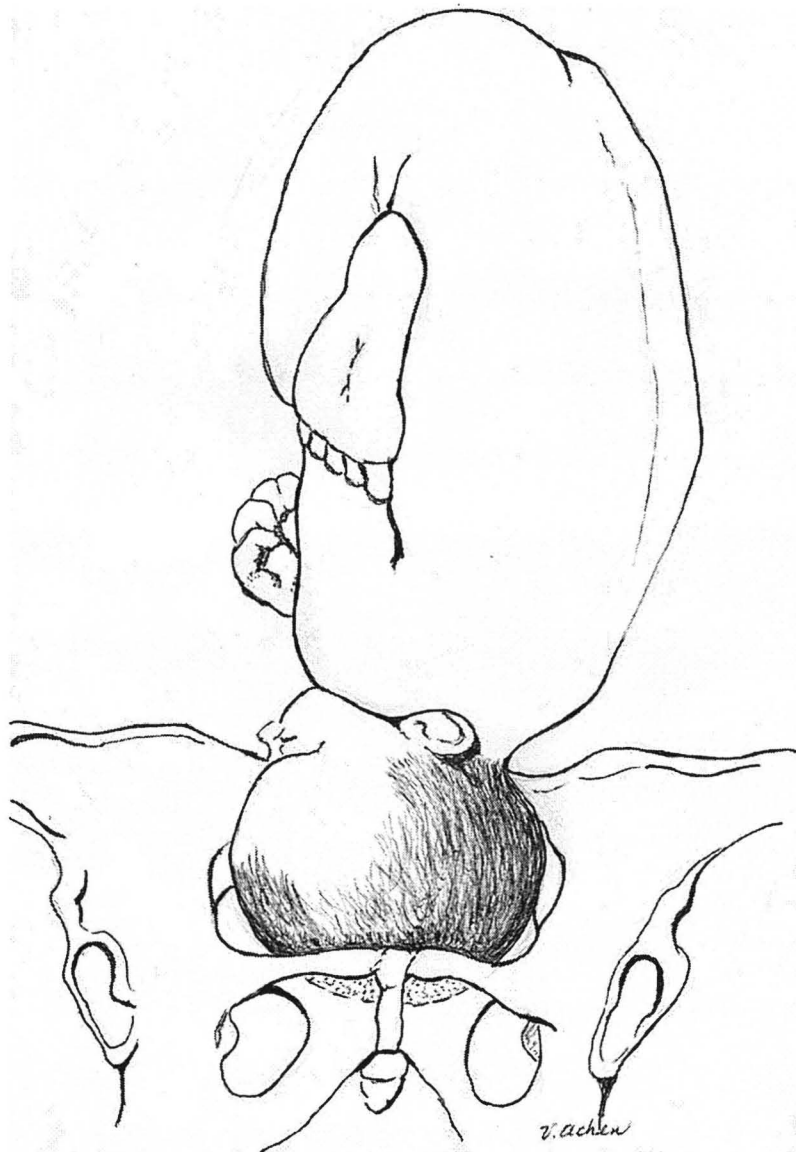


Figure 3. Left Occipital Anterior Position. Sketch by Virginia Achen.

### Clinical Presentation

When observed from an aerial view, the infant's head is distinctively misshapen. The parallelogram-shaped skull involves a unilateral flattening of the posterior aspect of the cranium, primarily in the parietooccipital region, concomitant with an ipsilateral protrusion of the forehead anteriorly (Figure 4). Associated with this cranial alteration, the ear on the side of the flattened occiput typically advances anteriorly as compared to the other ear.<sup>13,14,23,33,34,43</sup>

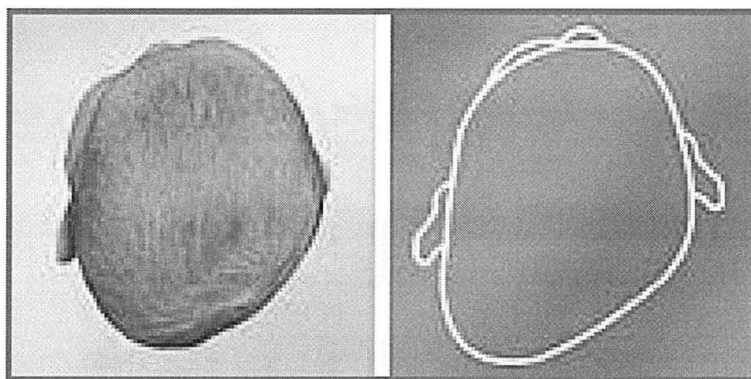


Figure 4. Aerial View of Positional Plagiocephaly.

Graphic representations of headshapes courtesy of Cranial Technologies, Inc.

Although a minor loss of hair or a “bald spot” on the back of the head is common in many supine sleeping infants, concern arises when it corresponds with a unilateral flattening of the occiput.<sup>34,43</sup> Approximately 10% of healthy infants under 8 weeks of age were identified as demonstrating a preferential positioning to one side, with a near 80% preference to the right.<sup>13,14</sup> According to Hutchison and colleagues,<sup>9</sup> 71.9% of infants with plagiocephaly at 6 weeks of age displayed strong preferential head positioning. If

the infant continues to sleep on the flattened area in the position of comfort, the cranium progressively deforms.<sup>14</sup> The sustained pressure to the occiput potentially leads to asymmetrical changes of the following facial features, particularly when paired with torticollis:<sup>34,44</sup> ears,<sup>34,43</sup> nose,<sup>36,43</sup> mandible,<sup>35,36,43</sup> zygomatic arches,<sup>36</sup> cheeks,<sup>43</sup> eyes<sup>36,43</sup> and epicanthal folds.<sup>43</sup>

The ear ipsilateral to the affected SCM is typically elevated and tilted anteriorly, displaying a cupped appearance, often referred to as “bat ear.” On the opposite side, the ear is flattened. Additionally, the eyes are malaligned, as the eye ipsilateral to the torticollis appears smaller and more superiorly positioned due to the pressure on the cheek.<sup>34,36,43,44</sup> Deviation of the tip of the nose and chin from midline may also occur.<sup>36</sup>

Of the facial anomalies, the flattening of the mandible ipsilateral to the torticollis side is most prominent initially. With the change in jaw and gumline contour, the temporomandibular joint is elevated from the upward inclination of the mandible, consequently inducing a “jaw tilt.”<sup>35,44</sup> Stellwagen and associates<sup>44</sup> speculated that this mandibular asymmetry may lead to difficulty with breastfeeding due to an impaired sucking mechanism,<sup>44</sup> potentially leading to further complications such as dehydration and weight loss.<sup>35</sup>

### Incidence

Although a precise incidence is yet to be determined, various studies have provided an estimated incidence of plagiocephaly.<sup>8-10,34,38,39,45</sup> Prior to 1996, the incidence of plagiocephaly was estimated by Clarren in Biggs<sup>34</sup> to be 1 out of every 300 infants (0.3%). However, more recently, studies have demonstrated the increasing

incidence of plagiocephaly, as this condition has since been estimated to have increased five-fold since the American Academy of Pediatrics' Back to Sleep Campaign.<sup>8-10,38,39</sup> In a 2004 study, Littlefield and associates<sup>45</sup> found this condition to occur in nearly 1 of every 68 live births (1.5%). Peitsch et al<sup>14</sup> found localized cranial flattening in as many as 13% of 201 healthy infants.

### Coexistence of Torticollis and Plagiocephaly

Literature indicates that both plagiocephaly and torticollis may exist as primary medical conditions, each displaying their respective classical clinical presentations as previously discussed.<sup>23</sup> A consistent correlation between these conditions has also been observed in the literature, with the infant displaying a mixed array of asymmetrical craniofacial and postural features.<sup>14,25,46</sup> Cheng et al<sup>28</sup> found plagiocephaly to coexist with torticollis in as many as 90.1% of infants.

Analogous to the “chicken and egg” phenomenon, inconsistencies exist regarding the causal relationship between torticollis and plagiocephaly. One viewpoint supported in literature suggests that torticollis is the primary medical condition.<sup>17,25-27,34,36</sup> Because of the unilateral shortening of the SCM, the infant develops an abnormal positioning of the head and neck, causing a preferred side preference while in supine. As the infant consistently lies on the occiput contralateral to the tight SCM, the ipsilateral occiput unloads. The prolonged, uneven weightbearing causes the cranium to deform, therefore, predisposing to unilateral posterior plagiocephaly.<sup>27</sup> Right-sided plagiocephaly being more frequently observed correlates with the higher incidence of left torticollis as compared to right.<sup>14,23,38</sup>



The opposing viewpoint to this causal relationship is that of plagiocephaly as the primary medical condition. At birth, the residual cranial abnormalities cause the infant's head to consistently lie in a position of preference, causing an ipsilateral shortening of the SCM muscle postnatally. With the head sustained in this position, the SCM becomes tight, as the infant is unable to actively move the head and neck from the preferred position, influencing the development of torticollis.<sup>23,27,34,46</sup>

### Risk Factors

In addition to the risk that these conditions pose to one another, numerous other factors have been proposed as increasing the susceptibility of infants developing torticollis or plagiocephaly.<sup>13-15,18,22,24,25,33,44</sup> Risk factors for torticollis predominantly parallel those for plagiocephaly: male gender,<sup>14,18,22,44</sup> primiparous mother,<sup>13,14,25,44</sup> multiple births,<sup>14,33,44</sup> prematurity,<sup>13,33</sup> low or large birth weight,<sup>33,44</sup> breech position,<sup>13,15,22,24,25</sup> assisted vaginal delivery (forceps or vacuum),<sup>14,22,25</sup> prolonged labor,<sup>14</sup> and maternal uterine abnormalities<sup>33,44</sup> (Table 1). Increasing plurality further increases the risk of plagiocephaly; evidenced by Littlefield and colleagues<sup>33</sup> reporting as many as 58.5% of twins, 66.7% of triplets, and 100% of quadruplets within their cohort who developed plagiocephaly.

Table 1. Risk Factors for Torticollis and Plagiocephaly	
Male gender	Breech position
Primiparity	Assisted vaginal delivery
Multiple births	Prolonged or difficult labor
Prematurity	Maternal uterine anomalies
Low birth weight	Supine sleep position
Large birth weight	

In addition to significant birth history details, supine positioning remains a key factor in the development of both plagiocephaly and torticollis, especially in the first few months postnatally.<sup>8,9,13,33,39</sup> Hutchison and colleagues<sup>9</sup> determined that supine sleeping position is a more significant risk for 6 week old infants as compared with 4 month olds. Factors such as unilateral breastfeeding, caregiver hand dominance and preferred carrying position of the infant, and mattress firmness have also been identified as risks, especially for plagiocephaly due to the sustained pressure to the infant's moldable head while being fixed in a static position.<sup>9,39,40</sup> State-wide regulations mandating a non-prone sleep position and the removal of soft bedding from cribs in daycare settings have further played into this risk.<sup>47</sup>

Another emerging risk for torticollis and plagiocephaly correlates with the amount of time infants spend in restrictive environments such as car seats, infant carriers, swings, walkers, exo-saucers, bouncy chairs, jumpers, and high chairs.<sup>39,44</sup> Littlefield<sup>39</sup> investigated the excessive use of car seats and swings over a three-year period, finding

56.6% of infants spent less than 1.5 hours, 28.6% spent 1.5 to 4 hours, and 14.8% spent greater than 4 hours each day. Additionally, 5.7% of infants slept in either a car seat or swing. Though this data was not directly correlated with development of torticollis or plagiocephaly, various infants in this study who spent extended time in a car seat or swing displayed cranial abnormalities.<sup>39</sup>

### Associated Conditions

Whereas torticollis and plagiocephaly can either be the underlying or secondary medical condition, the coexistence of these conditions tends to exacerbate the craniofacial abnormalities.<sup>22,23,36</sup> In addition to the facial asymmetries, other conditions have been correlated with torticollis and plagiocephaly.<sup>22</sup> From visual impairments to hip abnormalities, these associated conditions necessitate the need for a comprehensive developmental evaluation.

Developmental dysplasia of the hip is the most frequently associated pathology, occurring in as many as 17% of infants with torticollis.<sup>22,48</sup> This condition involves instability of the hip joint on the side of the torticollis, leading to subluxation or dislocation of the hip. Markedly limited hip abduction, asymmetry of skin folds, and an apparent leg length discrepancy are clinical determinants leading to the diagnosis of this condition.<sup>11</sup> Hip dysplasia leading to dislocation of the hip has been chiefly reported as coexisting with torticollis in approximately 8% of infants.<sup>7,13,17,22,48,49</sup>

Clubfoot entails the displacement of the navicular, calcaneus, and cuboid bones, leading to hindfoot equinus with forefoot and heel varus and forefoot adduction.<sup>11</sup> The infant's foot tends to be supinated inward and plantarflexed downward.<sup>33</sup> Association of

clubfoot, as well as scoliosis (curvature of the trunk), with plagiocephaly and torticollis arises from the abnormal positioning due to intrauterine constraint.<sup>11,49,50</sup>

#### Impact on Development and Function

Over half of the infants with plagiocephaly continue to display asymmetric features at 2 to 3 years of age, with 45% still showing a unilateral flattening of the occiput.<sup>13</sup> Approximately 10% of infants with plagiocephaly display mild to severe cosmetic deformities throughout life.<sup>40</sup> Although these cranial abnormalities persist, hair growth is likely to mask the asymmetry.<sup>7</sup>

In addition to the obvious cosmetic complications related to torticollis and plagiocephaly, gross motor development and cognition can be globally impacted.<sup>7,27,37,51</sup> Attaining milestones such as head control is critical for normal physical and cognitive development.<sup>12</sup> Hence, early identification of these conditions is necessary.

Due to the muscular imbalance associated with torticollis, the acquisition of head control and active positioning of the head in midline by 3 months of age is typically delayed.<sup>12</sup> The persistence of torticollis has been reported by Karmel-Ross<sup>6</sup> as leading to delayed integration of primitive reflexes and intensified abnormal cervical spine posturing. Essentially, these underlying abnormalities may cause an overall asymmetric development of sensorimotor, vestibular, and proprioceptive systems. As these base elements mature asymmetrically, vision, postural reactions, and gross motor activities performed in all positions are impaired on the side ipsilateral to the affected SCM muscle, while the contralateral side tends to develop normally.<sup>6</sup> Due to lack of equal

development bilaterally, weightbearing activities requiring coordination and weight shifts such as reaching, sitting, crawling, and walking may be difficult.<sup>32</sup>

Although a slight delay in early gross motor milestones has been identified in supine sleeping infants, these delays have not directly been correlated with long-term complications.<sup>51</sup> However, Miller and Clarren<sup>37</sup> found that 39.7% of children who displayed plagiocephaly as infants required greater assistance in school, receiving: special education, physical and occupational therapy, and speech language therapy services provided through an Individual Education Plan (IEP). An increased risk of “auditory processing disorders” and visual complications including strabismus are also common.<sup>7,10</sup>

### Evaluation

Because of the profound effects torticollis and plagiocephaly have on development and function, a comprehensive history taking and thorough examination is necessary. A detailed history should include all aspects of prenatal, obstetric, and neonatal events including: gender; prematurity; normal vaginal, cesarean section, or assisted delivery; breech presentation at birth; birth weight; parity; plurality; nursing habits; sleeping position, use of restrictive environments, and time spent in prone, as well as any congenital disorders.<sup>6,13,23,33</sup> Risk factors identified from the caregiver or parent interview guide the physical component of the evaluation.

### Physical Examination

During the physical examination, various facets of infant development should be assessed including visual field tracking, auditory integrity, and musculoskeletal

components.<sup>17,26</sup> An infant with torticollis will have deficits in cervical range of motion, particularly with limitations of lateral flexion contralateral to the affected SCM and rotation ipsilaterally.<sup>6,17,20,43</sup> Palpation of both SCM muscles for a fibromatosis colli, tightness, or increased tone is necessary to help determine the presence and side of torticollis.<sup>17,27,43</sup>

Observation of the infant should take place from anterior, lateral, posterior, and aerial views in order to obtain a complete clinical picture of torticollis or plagiocephaly as described previously. For plagiocephaly, it is increasingly important to palpate the cranial sutures for differential diagnosis as to the cause of plagiocephaly.<sup>23,34,43</sup> Numerous techniques for obtaining craniofacial measurements have been identified in literature for establishing a baseline of cranial morphology, as well as the use of clinical photography for objectively evaluating change over time.<sup>43</sup> The selection of a specific measuring technique is of lesser importance than the consistency, reproducibility, and effectiveness of the test selected.<sup>43</sup> Specifically, severity assessments with a graphic representation may be useful for determining the initial clinical presentation of plagiocephaly (Appendix A).

### Screening Tools

Healthcare professionals may use a variety of approaches for evaluating a child's development. Methods of early identification include monitoring developmental milestones, parental recall of milestones and current achievements, developmental screening tests, and clinical judgment.<sup>52</sup> As each method has advantages and limitations, many practitioners may choose to use a combination of methods.

One of the most well known and widely used screening tools is the Denver Developmental Screening Test II. This norm-referenced, standardized test screens for development in gross and fine motor, language, and personal-social domains in children aged 1 week to 6.5 years.<sup>11,52</sup> Due to the weak specificity and sensitivity, children with developmental delay may be missed, while normally developing children may be identified as possibly having developmental delay.<sup>52,53</sup>

Because development is a dynamic, complex process, it is difficult to assess a child's overall development at a single screening.<sup>52</sup> For this reason, the concept of developmental surveillance through parental evaluation has proven to be an effective element of screening. The Ages and Stages Questionnaire (ASQ), 2<sup>nd</sup> ed. is a norm-referenced, standardized parental report of communication, gross and fine motor, problem solving, and personal-social development for children 4 months to 60 months of age, which is used to determine areas requiring further testing.<sup>11</sup>

Another screening tool that accounts for prematurity is the Test of Infant Motor Performance (TIMP). This assessment can be used with premature infants born at 34 weeks gestation, up to 4 months postnatally, to observe functional movements of the head and trunk in prone, supine, and upright positions.<sup>6,11</sup> The TIMP is sensitive to the effects of intervention and discriminates infants at risk for poor motor outcomes.<sup>11</sup>

### Diagnosis

Torticollis and plagiocephaly is diagnosed based on the findings from the history and clinical evaluation. A physical therapy diagnosis for these conditions fits under the Guide to Physical Therapist Practice<sup>54</sup> Pattern 4B: Impaired posture. The ICD-9-CM

codes covering these conditions include 723.5 Torticollis, unspecified and 738 other acquired deformity (plagiocephaly).

Age of an infant at initial diagnosis of torticollis follows a common tendency, with the majority of cases presenting within the first 3 months of age.<sup>20,22,23</sup> In a study of 821 infants, Cheng and associates<sup>20</sup> identified 24% of infants initially presented with torticollis within the first month following birth, 44% presented between 1 and 3 months, 23% between 3 and 6 months, and only 10% between 6 and 12 months. In another study involving 510 infants, Cheng and colleagues<sup>22</sup> found that 92.7% of torticollis cases were identified during the first 3 months of life.

Plagiocephaly tends to present in infants at approximately the same age as torticollis. De Chalain and Park<sup>23</sup> observed referral trends in infants with plagiocephaly and found 54% of infants were referred at less than 3 months of age, 39% referred at 3 to 6 months, 6% at 6 to 9 months, and only 1% at 9 to 12 months. Hutchison and colleagues<sup>9</sup> found a 10.5% prevalence at 6 weeks of age, 6.1% at 4 months of age, 1.5% at 8 months of age, and no new cases presenting after 8 months of age.

#### Differential Diagnosis

If no involvement of the SCM is identified during the physical examination, diagnostic imaging such as computed tomography or magnetic resonance imaging may be required to identify any underlying origin of abnormal head and neck posturing.<sup>23</sup> Other orthopedic conditions such as Klippel-Feil syndrome, C1-C2 rotary subluxation, cervical scoliosis, or hemivertebrae may also appear as abnormal posturing of the head,



mimicking torticollis.<sup>23,27,55</sup> Neurological causes such as brachial plexus injury may also pose as skeletal abnormalities.<sup>6</sup>

Ocular lesions may also induce a torticollis posturing.<sup>23,26,29,55,56</sup> Unilateral weakness of the extraocular muscles, especially the superior oblique, cause the infant to tilt or rotate the head to one side to compensate for diplopia or double vision.<sup>23,27</sup> As an infant does not develop binocular vision until 3 or 4 months of age, nor is able to sit independently until approximately 6 months of age, an ocular cause of torticollis is unlikely prior to 6 months of age.<sup>23</sup> Cheng and Tang<sup>56</sup> found ocular problems in 7.1% of children with tightness of the SCM muscle.

Differentially diagnosing deformational plagiocephaly from synostotic plagiocephaly is critical due to the varying clinical outcomes and treatment.<sup>34</sup> Synostotic plagiocephaly, involving premature fusion of cranial sutures, occurs in only 1 of every 100,000 infants.<sup>38</sup> A palpable ridge at the fused suture, posteriorly displaced ear on the side of flattening, and unilateral occipital flattening unaccompanied by a protruding forehead are indicative of synostotic plagiocephaly.<sup>34</sup>

#### Treatment

In 50% to 70% of cases, infants with tumors of the SCM tend to have spontaneous resolution of the tumor within the first year of life, which may or may not leave residual tightness of the SCM requiring formal intervention.<sup>26</sup> There are a variety of treatment options, ranging from conservative, non-invasive techniques to surgery, that can combat the detrimental effects of torticollis and plagiocephaly.<sup>6,19,21,24,26,29,31,32,34,37,56-59</sup> Initiation

of a treatment plan early on, as well as the prevention of these conditions, has proven to yield positive outcomes for children.<sup>6,31,32,34</sup>

### Conservative Treatment

Conservative interventions are the first plan of care option in treating children with torticollis. Manual stretching programs and range of motion exercises are the most common conservative treatments for torticollis, which can be carried out while holding, carrying, and playing with the infant in positions that achieve the desired active or passive movements.<sup>21,24,27,32</sup> A complete program should address any restricted motions of the cervical spine including lateral flexion, rotation, flexion, and extension, as well as trunk elongation on the side ipsilateral to the torticollis.<sup>21,24,32</sup> During manual stretching, a “snapping” or sudden giving way of the SCM muscle may occur, often producing an audible click.<sup>60</sup> This may cause localized ecchymosis, but has no long-term adverse effects.<sup>26,60</sup>

The most involved muscles and respective motions should be stretched first, primarily the SCM muscle.<sup>32</sup> Prior to stretching, massage, heat, or slight traction can be performed to prepare the tissues and increase relaxation.<sup>27,32</sup> Benefits of performing a home stretching program include the ability of the parents to complete the stretching on a daily basis to accelerate the resolution of torticollis.<sup>6,32</sup>

In conjunction to the stretching program, the caregivers should be educated on environmental modifications,<sup>1,32</sup> carrying techniques,<sup>6,21,24,32,34</sup> feeding modifications,<sup>1,34</sup> and positioning.<sup>1,6,21,24,32</sup> Emery<sup>24</sup> recommends the stretching program be preformed twice daily, with 5 repetitions of each exercise, holding each stretch for 10 seconds.

Other researchers have advocated that the infant's home program be completed as often as 4 to 8 times per day.<sup>21,29</sup> Discharge goals of the stretching program include full symmetrical passive cervical range of motion.<sup>24</sup>

Other conservative treatments for infants at least 4 months of age involve the use of an orthotic device or a tubular orthosis for torticollis (TOT collar).<sup>6</sup> Orthotics are comprised of soft tubing that limits lateral flexion to the side of the torticollis. This is an active treatment, as infants wear the device while awake, adding to the treatment program by increasing the amount of time the correction takes place.<sup>6,24,32</sup> When traditional treatment techniques as previously discussed have been unsuccessful, the use of botulinum toxin type A may be indicated.<sup>31</sup>

Initially, treatment for plagiocephaly involves positioning of the head to the uninvolved side during activities such as sleeping, feeding, and carrying or handling by the caregiver in order to unweight the skull.<sup>6,34</sup> Because 80% to 85% of cranial growth occurs in the first 12 months of life, the use of an orthotic device may be required if conservative positioning techniques have been unsuccessful after 4 to 8 weeks.<sup>34</sup> Custom head orthoses (helmets) are often used between 6 and 18 months of age<sup>37</sup> to correct the effects of plagiocephaly, by helping to decrease the pressure at the area of the flattening and allow for continued cranial growth.<sup>6,34</sup>

#### Surgical Intervention

In the cases where either conservative therapy proves unsuccessful in the resolution of torticollis after 6 months or when the condition persists until 1 year of age, surgery may be indicated.<sup>15,56,57</sup> The primary goal of surgery is to release or lengthen the

SCM, allowing for improved cervical range of motion. A variety of techniques used to accomplish the desired outcome include endoscopic release<sup>56,57,59</sup>; bipolar release with inferior Z-plasty<sup>58</sup>; open release of the upper, middle, or lower portion of the muscle<sup>56</sup>; tendinous attachment release<sup>59</sup>; stair-step lengthening<sup>59</sup>; and radical resection.<sup>56,59</sup> Randomized control trials comparing the outcomes of the various surgical methods have yet to be conducted.<sup>56</sup>

### Outcomes

Complete resolution of torticollis is usually accomplished with early initiation of treatment and adherence to a rigorous conservative treatment plan.<sup>6,19,21,29</sup> A prospective study by Celayir<sup>21</sup> found a 100% success rate in 45 infants under 4 months of age diagnosed with torticollis, utilizing an intensive stretching protocol. The plan of care consisted of passive stretching and parent education for positioning and handling techniques.<sup>21</sup> Another study<sup>29</sup> with a similar treatment protocol found that 28 (100%) infants when referred prior to 3 months of age had full recovery, while 12 (75%) of 16 infants had full recovery when referred between 3 and 6 months, and only 2 (29%) of 7 infants had complete resolution when referred at 6 to 18 months. A complete and early conservative treatment program is of vital importance to reduce the deformity and prevent the need for surgical intervention.<sup>6,19,29</sup>

When surgical intervention is necessary, release of the SCM muscle is generally successful.<sup>56-58</sup> Cheng and Tang<sup>56</sup> found that 89% of children regained normal ranges of lateral flexion, and 77% had no residual head tilt following surgery. Early detection and

surgical treatment prior to age 3, in conjunction with adherence to a postoperative treatment program, yielded excellent results for the resolution of torticollis.<sup>56</sup>

### Prevention

Even more important than early recognition and treatment of torticollis and plagiocephaly, prevention is advocated to avoid developmental complications. Success with prevention should start with education to parents and caregivers.<sup>34</sup> Education provided should include encouraging supervised daily prone playtime, alternating side of feeding, discouraging the use of restrictive environments and counterpositioning by alternating the end of the crib that the infant's head is placed.<sup>1,33,34,39</sup> Tummy time can be implemented as early as the first day by placing the infant on the caregiver's chest.<sup>1</sup>

Often the prone positioning can be uncomfortable for infants initially; methods to make tummy time more tolerable may include placing toys in front of the child and having the caregiver accompany the infant on the floor.<sup>34</sup> Short bouts of tummy time, 2 to 3 times throughout the day, will help the infant become more comfortable with the prone position. Over time, the infant gains strength in his or her neck and upper extremities, allowing for transitional movements and the acquisition of developmental milestones.<sup>1</sup>

### CHAPTER III

#### METHODOLOGY

Permission for this research project, along with written consent, was obtained from the regional director of an infant and toddler developmental screening program of a midwestern state. Release of the developmental screening charts for review was granted to the researchers. Prior to the chart review, approval for the use of human subjects for this study was obtained from the University of North Dakota Institutional Review Board; permission was granted on May 22, 2006.

#### Subjects

The charts reviewed in this study consisted of developmental screening charts for children aged birth to 3 years, which were comprised of a one-page form completed by a professional screener each time the child was screened (Appendix B). Supplementary information such as referral forms and hospital discharge information with birth details was also available in some charts.

Prior to the chart review, a study of ten randomly selected charts was completed in order to determine inclusion criteria. The following inclusion criteria was established:

1. The charts must be of open status and children must qualify for developmental screening.
2. The initial screening must have taken place between the dates of July 2004 and July 2006.

3. The children must have been 9 months of age or younger at the date of the initial screen.

#### Instrumentation

A chart review form (Appendix C) was created by the researchers for data collection. Data points collected included: dates of screenings, age of the child at each screen, discipline of the professional performing the screen, use of a developmental screening tool, birth history, perinatal details, birth weight, gender, and family history of torticollis. A section for additional history comments was also included. Additional data points specific to each screen included: plagiocephaly, side preference, head tilt, limitations in cervical range of motion, abnormal sternocleidomastoid muscle, hip abnormalities, vision involvement, upper extremity asymmetry, trunk asymmetry, and education regarding tummy time.

#### Data Collection

Chart review took place at the screening program's regional office. The director of the program provided researchers with a list of open charts by a variety of screeners. Utilizing a sample of convenience, charts were reviewed based on availability and accessibility to reviewers.

Identifying information linking the child to the chart review form was recorded on a coding sheet, in order to return to specific charts during data analysis if needed. All charts meeting inclusion criteria were read in their entirety. Collaboration took place among researchers to determine relevance of information to be included in the additional comments section. Information regarding referrals and relevant diagnoses on were also

included. A chronological age calculator<sup>61</sup> was used to determine the age of the child in months, days, and years at each screen.

### Statistical Analysis

At the completion of the chart review, data from the charts meeting inclusion criteria were analyzed using the Statistical Package for Social Sciences (SPSS) version 11.0.<sup>62</sup> Descriptive statistics including means, standard deviations, and ranges were calculated for birth weight and age of each infant from the first developmental screening. Additional descriptive statistics consisting of frequencies and percentages were calculated for incidences of torticollis and plagiocephaly, gender, prematurity, delivery, plurality, and family history of torticollis. Chi-square tests for independence were calculated to determine the relationship between the presence of plagiocephaly and torticollis diagnostic indicators (cranial flattening, head tilt, and side preference) and risk factors, tummy time education, or use of the Denver Developmental Screening Test II. Data were arranged in 2x2 tables using  $\chi^2$  analysis with continuity correction for cells with an expected frequency less than 5.

Analytical statistics were calculated using the independent-measures t-test for determining the difference in birth weight and age at first screen between infants with or without the presence of diagnostic indicators. The alpha level for determining significance was set at .05 for all statistical tests.



## CHAPTER IV

### RESULTS

#### Subject Profile

One hundred twenty-five charts were reviewed, with 90 charts meeting the established inclusion criteria. Exclusion of 35 charts was required, as 26 charts involved the initial screen prior to July of 2004, and 9 charts were excluded for age requirements. The mean birth weight was 7.43 pounds, ranging from 3.38 to 10.07 pounds; the mean age at first screen was 1.92 months, ranging from 0.33 to 8.07 months. Additional demographic characteristics including frequencies and percentages of gender, prematurity, delivery, plurality, and family history of torticollis are available in Table 2.

#### Risk Factors

Chi-square test for independence was used to determine the difference between risk factors such as male gender,<sup>14,18,22,44</sup> vacuum assisted delivery,<sup>14,22,25</sup> and prematurity<sup>13,33</sup> and the presence of diagnostic indicators of torticollis and plagiocephaly (Table 3). In this sample of charts, no significant relationship was found between gender and presence of diagnostic indicators,  $X^2 (1, n = 90) = .775, p > .05$ . There was also no significant relationship found between vacuum assisted delivery and the presence of diagnostic indicators,  $X^2 (1, n = 74) = .889, p > .05$ . Additionally, no significant relationship was found between prematurity and presence of diagnostic indicators,  $X^2 (1, n = 74) = .013, p > .05$ .

Table 2. Demographic Characteristics			
Variable	Number of Subjects (%)	Mean $\pm$ SD	Range
<b>Birth Weight (in Pounds)</b>			
Documented	79 (87.8)	7.43 $\pm$ 1.51	3.38 – 10.07
Not Documented	11 (12.2)		
<b>Age at First Screen (in Months)</b>	90 (100.0)	1.92 $\pm$ 1.45	0.33 – 8.07
<b>Gender</b>			
Male	57 (63.3)		
Female	33 (36.7)		
<b>Premature</b>			
Yes	14 (15.6)		
No	60 (66.7)		
Not Documented	16 (17.8)		
<b>Cesarean Delivery</b>			
Yes	25 (27.8)		
No	50 (55.6)		
Not Documented	15 (16.7)		
<b>Breech Delivery</b>			
Yes	0 (0.0)		
No	74 (82.2)		
Not Documented	16 (17.8)		
<b>Forceps Assisted Delivery</b>			
Yes	0 (0.0)		
No	74 (82.2)		
Not Documented	16 (17.8)		
<b>Vacuum Assisted Delivery</b>			
Yes	8 (8.9)		
No	66 (73.3)		
Not Documented	16 (17.8)		
<b>NSVD</b>			
Yes	39 (43.3)		
No	33 (36.7)		
Not Documented	18 (20.0)		
<b>Plurality</b>			
Single Birth	70 (77.8)		
Twin	4 (4.4)		
Triplet	3 (3.3)		
Not Documented	13 (14.4)		
<b>Family History of Torticollis</b>			
Yes	0 (0.0)		
No	0 (0.0)		
Not Documented	90 (100.0)		

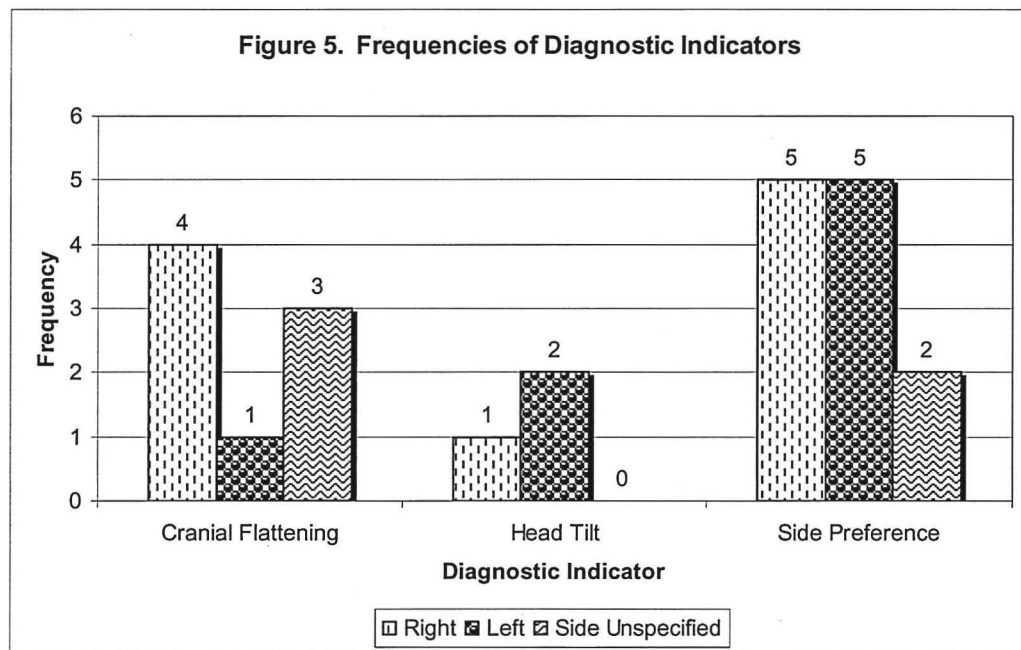
Table 3. Relationships Between Risk Factors and Presence of Diagnostic Indicators							
Risk Factor			Indicator Present		X <sup>2</sup>	df	P
Gender			No	Yes	.775	1	.379
Male	Observed		46	11			
	Expected		48	10			
Female	Observed		29	4			
	Expected		28	6			
Vacuum Assisted Delivery			No	Yes	.889 <sup>a</sup>	1	.346
No	Observed		55	11			
	Expected		54	13			
Yes	Observed		5	3			
	Expected		7	2			
Prematurity			No	Yes	.013 <sup>a</sup>	1	.910
No	Observed		48	12			
	Expected		49	11			
Yes	Observed		12	2			
	Expected		11	3			
<sup>a</sup> Continuity correction for a 2x2 table.							

Extremes of both high and low birth weights have been shown to increase the infant's risk of developing plagiocephaly and torticollis.<sup>33,43</sup> Independent measures t-test was used to compare birth weights of infants with and without a diagnostic indicator present. No significance difference was found between groups,  $t(77) = -0.26$ ,  $p = .980$  (Table 4).

Table 4. Means, Standard Deviations, and T-tests for Differences in Birth Weight (in Pounds) Between Infants With or Without Diagnostic Indicators						
	n	Mean	SD	t	df	P
Indicator Absent	64	7.43	1.58	-0.26	77	.980
Indicator Present	15	7.44	1.25			

## Diagnostic Indicators

Twenty-three diagnostic indicators including cranial flattening, head tilt, and side preference were identified in 15 infants (Figure 5). Side preference was the most frequently reported indicator ( $n = 12$ ), followed by cranial flattening ( $n = 8$ ) and head tilt ( $n = 3$ ). Additional indicators represented in documentation included one infant with facial asymmetry in conjunction with the cranial flattening, and another infant with a bald spot over the cranial flattening.



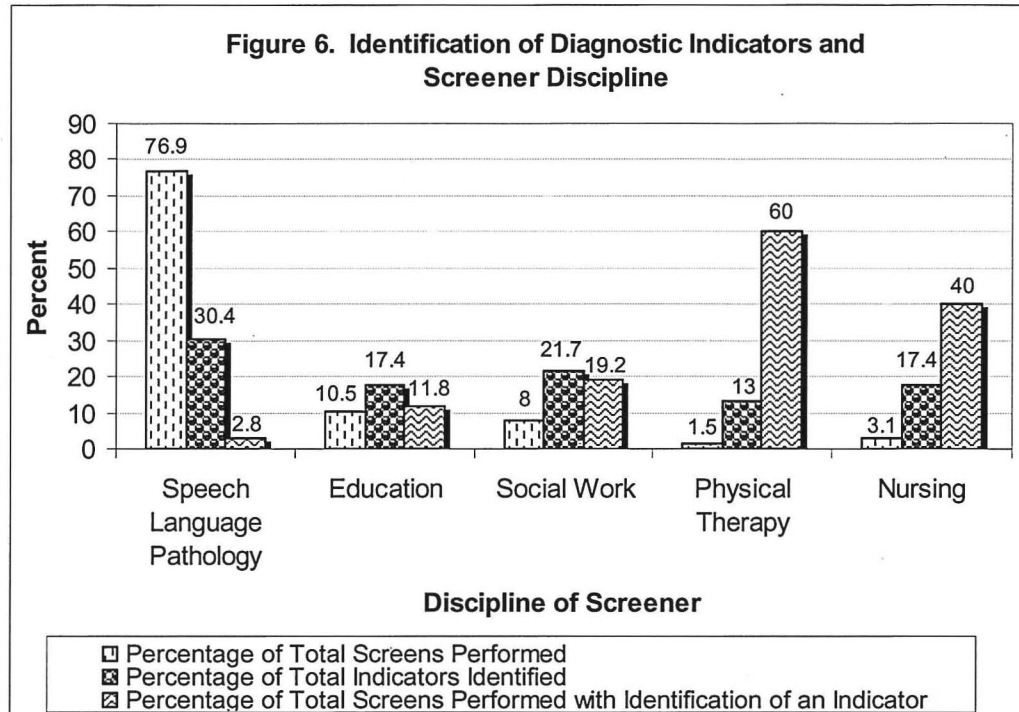
## Incidence

In the chart review, plagiocephaly was identified by the developmental screeners in 8 (8.9%) infants. A right-sided flattening was found in 4 (50%), whereas left-sided flattening was found in 1 (12.5%). In 3 (37.5%) infants with plagiocephaly, the side of

the flattening was unspecified as per documentation in the developmental screening charts. Torticollis was identified by the developmental screeners in 3 (3.3%) infants. A right-sided head tilt was found in 1 (33.3%) infant, while left-sided head tilt was found in 2 (66.7%) infants.

#### Discipline of Screeners

Five professional disciplines (speech language pathology, education, social work, physical therapy, and nursing) were represented in this sample. The charts reviewed included a total of 325 developmental screens performed by screeners of the aforementioned disciplines. Of the 325 screens, 250 (76.9%) were performed by speech language pathologists, 34 (10.5%) by education professionals, 26 (8.0%) by social workers, 5 (1.5%) by physical therapists, and 10 (3.1%) by nurses. Speech language pathologists identified 7 (30.4%) of the 23 total diagnostic indicators documented, education professionals identified 4 (17.4%), social workers identified 5 (21.7%), physical therapists identified 3 (13.0%), and nurses identified 4 (17.4%). In 2.8% of screens performed by speech language pathologists, 11.8% of screens performed by education professionals, 19.2% of screens performed by social workers, 60.0% of screens performed by physical therapists, and 40.0% of screens performed by nurses, a diagnostic indicator of torticollis or plagiocephaly was identified (Figure 6).



### Developmental Screening Tool

For the developmental screens, the use of a standardized screening tool was an elective option to each screener. The Denver Developmental Screening Test II was the most frequently utilized screening tool (68.3%), followed by the Ages and Stages Questionnaire (4.0%) and a combination of both screening tools at (0.3%). No developmental screening tool was used at 27.4% of the screens.

Chi-square test of independence was used to determine whether a relationship existed between the use of either the Denver II or no screening tool at the first screen and the identification of a diagnostic indicator at the first or any subsequent screens. No significant relationship was found between the use of a screening tool and identification of a diagnostic indicator,  $\chi^2 (1, n = 90) = 3.416, p > .05$  (Table 5).

Table 5. Relationship Between Screening Tool and Presence of Diagnostic Indicators						
		Indicator Present		X <sup>2</sup>	df	P
Screening Tool		No	Yes	3.416 <sup>a</sup>	1	.065
No Tool	Observed	19	0			
	Expected	16	3			
Denver II	Observed	56	15			
	Expected	59	12			
<sup>a</sup> Continuity correction for a 2x2 table.						

### Tummy Time Education

At their discretion, screeners provided education to the parents regarding the placement of their infant in prone or on the tummy to play. On the first developmental screen, tummy time education was provided for 81.4% of the infants younger than 2 months of age and 76.9% for infants 2 months of age or older. Using the  $X^2$  test for independence, there was no significant relationship found between tummy time education and the identification of a diagnostic indicator for plagiocephaly or torticollis,  $X^2 (1, n = 90) = .006, p > .05$  (Table 6).

Table 6. Relationship Between Tummy Time Education and Presence of Diagnostic Indicators						
		Indicator Present		X <sup>2</sup>	df	P
Tummy Time Education		No	Yes	.006 <sup>a</sup>	1	.940
No	Observed	15	2			
	Expected	14	3			
Yes	Observed	57	11			
	Expected	58	10			
<sup>a</sup> Continuity correction for a 2x2 table.						

### Age at Initial Screen

Diagnosis of torticollis and plagiocephaly tends to transpire within the first three months after birth.<sup>18,20,21</sup> Therefore, early screening and preventative education are essential for infants and their caretakers. Independent measures t-test was calculated to determine whether there was a difference in the age of infants at initial screen between infants with or without a diagnostic indicator present. No significant difference was found in age between infants with or without a diagnostic indicator of torticollis or plagiocephaly  $t(88) = 1.62, p = .110$  (Table 7).

Table 7. Means, Standard Deviations, and T-tests for Differences in Age (in Months) at Initial Screening Between Infants With or Without Diagnostic Indicators						
	n	Mean	SD	t	df	P
Indicator Absent	75	2.03	1.54	1.62	88	.110
Indicator Present	15	1.37	0.65			



## CHAPTER V

### DISCUSSION

The estimated incidence of torticollis within this developmental screening program for infants and toddlers was relatively consistent with previously reported incidences ranging from 0.3% to 2.0%.<sup>6,16,18,23,26,27,30</sup> The slightly higher incidence of 3.3% in this sample may, in part, be attributed to the limitations of the study. Left-sided head tilt was more common than right-sided as in prior studies<sup>11,15,17-22</sup> with percentages ranging from 46.6% to 68%, compared with 66.7% in this study.

Plagiocephaly or cranial flattening was identified in 8.9% of the charts reviewed in this study. This incidence is considerably higher than findings from previous studies.<sup>34,45</sup> with incidences of deformational plagiocephaly ranging from 0.3% to 1.5%. Conversely, Peitsch et al<sup>12</sup> found a 13.0% incidence of “localized cranial flattening” in 201 infants, as these researchers specified that a local area of cranial flattening did not necessarily constitute fully developed deformational plagiocephaly. Furthermore, Boere-Boonekamp and associates<sup>11</sup> estimated a prevalence of plagiocephaly as 9.9% in all children under 6 months of age. The incidence of plagiocephaly from this present chart review more closely resembles these findings<sup>11,12</sup> because professional screeners used a visual assessment of cranial flattening as a diagnostic indicator for plagiocephaly, rather than a quantifiable, objective measure of the severity of cranial flattening.

Right-sided cranial flattening identified in 50% of infants coincides with 54.2% reported for right-sided involvement by Peitsch et al.<sup>12</sup> However, for nearly 38% of the cases of plagiocephaly in this study, the affected side of cranial flattening was not specified in the documentation of the developmental screening charts.

Numerous risk factors such as male gender, birth details, and perinatal events have been reported in literature as predisposing infants to torticollis and plagiocephaly.<sup>11-13,16,20,22,23,33,43</sup> Male gender, prematurity, and vacuum assisted delivery were not significantly related to the presence of diagnostic indicators in this study. The lack of significance could possibly be attributed to the incomplete birth history and perinatal details available in the charts, as approximately 18% of charts were missing details regarding prematurity and vacuum assisted delivery.

Although significance was not determined for the data, identification rates across disciplines were expected to have been evenly distributed under a null hypothesis. In this particular screening program, speech language pathologists were utilized most often (76.9%). This discipline was responsible for identifying a diagnostic indicator in 2.8% of the total screens performed by speech language pathologists. In contrast, screeners from a physical therapy background completed 1.5% of the total screens, and identified a diagnostic indicator in 60% of the screens performed. The high identification rate among physical therapy professionals may partially be explained in that professionals from a musculoskeletal background, such as physical therapists, may have been specifically brought in for further assessment.

## Limitations

Due to the small sample size and inability to randomize the selection of charts prior to review, the incidence of torticollis and plagiocephaly may not be generalizable to the population of infants within this developmental screening program. Another limitation of this study was incomplete referral, history, follow-up, and further detailed information in some of the developmental screening charts. Missing information from the charts not only limited data collection and analysis for this study but also potentially could influence the identification and referral process for infants with torticollis and plagiocephaly.

## Recommendations

Use of a standardized intake form to gather birth history, past medical history, and family history information may benefit this program by providing comprehensive details about each infant or toddler to professional developmental screeners. Having this background information could enhance the clinical picture of each infant to determine his or her individual assessment needs. A significant birth history may necessitate closer attention to areas of developmental concern, such as specifically assessing for torticollis or plagiocephaly. Severity assessments for plagiocephaly and torticollis (Appendix A) could be incorporated to evaluate the extent of involvement, as well as provide an objective baseline for monitoring and/or referral.

In the findings from our study, the average age at first screen was under 2 months of age, with a range of 10 days to 8 months. Since the majority of cases with torticollis and plagiocephaly tend to present within the first 3 months of life,<sup>18,20,21,31</sup> it is

increasingly important for the continuation of early screening within this program.

Further expansion of early screening services may help to identify and refer for early initiation of treatment for improved outcomes.

Future research in this area may expand to include training needs of developmental screeners within this program regarding documentation, administration of developmental screening tools, and knowledge base for the identification of torticollis and plagiocephaly. Additional research is needed for determining whether the Denver Developmental Screening Test II is the most appropriate screening tool for the majority of children within this program. Although the Denver II has been widely accepted as a developmental screening tool, the appropriateness of using other screening tools such as the Test of Infant Motor Performance should be explored, especially with children at risk for developing torticollis and plagiocephaly.

### Conclusion

Prevalence of torticollis and plagiocephaly in this chart review is comparable to previously reported incidences. Aforementioned recommendations have the potential to benefit future recipients through the enhancement of the services provided by this developmental screening program. Greater awareness and education of the professional screeners may improve the preventative services and identification of torticollis and plagiocephaly to ensure healthy infant development.

## APPENDIX A

# Severity Assessment for *PLAGIOCEPHALY*

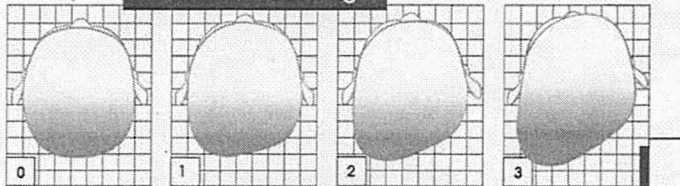
Patient Name \_\_\_\_\_

Sex ☐ M ☐ F

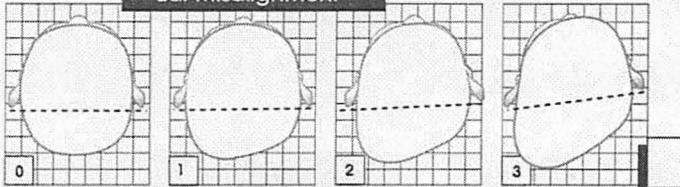
Date \_\_\_\_\_

Date of Birth \_\_\_\_\_

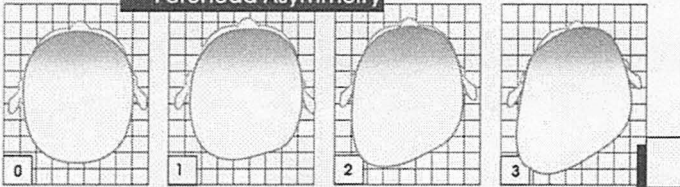
## Posterior Flattening



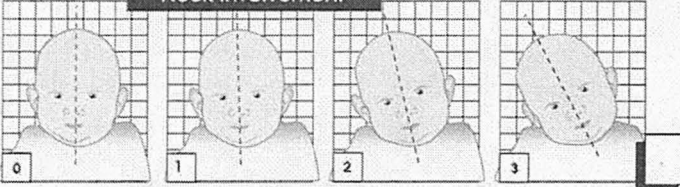
## Ear Misalignment



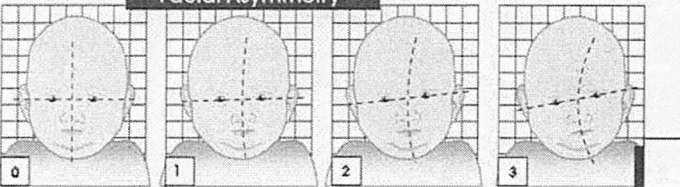
## Forehead Asymmetry



## Neck Involvement



## Facial Asymmetry



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Notes

TOTAL SCORE

Severity Assessment courtesy of Cranial Technologies, Inc.

## APPENDIX B

Child's Name:

Date of Birth:

Parents:

Referral Source:

Consultant:

Address:

Date Assigned:

Phone :

E-mail:

Time and Date of visit \_\_\_\_\_

Significant History/Schedule:

Pediatrician/Physician: \_\_\_\_\_  
Information to be sent to Pediatrician/Physician: Yes \_\_\_\_ No \_\_\_\_

Screening Results and or Observations/Comments:

---

---

Plan/Developmental Activities:

---

---

Information Given to Parents and/or Community Referrals:

---

---

Rescreen Date: \_\_\_\_\_ Signature: \_\_\_\_\_



## APPENDIX C

**Torticollis Chart Review Form**

ID Code \_\_\_\_\_

Review Date \_\_\_\_\_

Reviewer initials \_\_\_\_\_

**Screening Information**

	Date	Age - yr/mo/day	Discipline	Tool
Initial Screening-1				
Screening-2				
Screening-3				
Screening-4				
Screening-5				
Diagnosis of torticollis				
Referral for Evaluation				

**Patient/Family History:**

Birth Weight		
Sex	M	F
Family history of torticollis	yes	no
Cesarean section delivery	yes	no
Breech delivery	yes	no
Forceps or vacuum used	yes	no
Single birth	yes	no
Premature	yes	no

**Additional History Comments:**


**Initial Screening-1**

Indicator	Right	Left
Plagiocephaly		
Side preference		
Head tilt		
Decreased cervical rotation		
Decreased cervical flexion		
Decreased cervical extension		
Decreased cervical side bending		
Abnormal SCM muscle		
Hip abnormalities		
Vision involvement		
Upper extremity asymmetry	yes	no
Trunk asymmetry	yes	no
Education: tummy time	yes	no
Other		
Other		

**Clinical Indicators Documented:****Screening-2**

Reason: routine \_\_\_\_\_ referral \_\_\_\_\_

Indicator	Right	Left
Plagiocephaly		
Side preference		
Head tilt		
Decreased cervical rotation		
Decreased cervical flexion		
Decreased cervical extension		
Decreased cervical side bending		
Abnormal SCM muscle		
Hip abnormalities		
Vision involvement		
Upper extremity asymmetry	yes	no
Trunk asymmetry	yes	no
Education: tummy time	yes	no
Other		
Other		

**Other Comments:**


**Reason for referral and to what discipline:**

--

**Education provided:**

--

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